CORN GROWING UNDER DROUGHTY CONDITIONS

C. P. HARTLEY
Physiologist in Charge, and

L. L. ZOOK
Physiologist, Office of Corn Investigations

FARMERS' BULLETIN 773
UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Washington, D. C. December, 1916

CORN GROWING UNDER DROUGHTY CONDITIONS.

CONTENTS.

INTRODUCTION.

For 50 years new settlers from the East have attempted to grow corn in the semiarid West. The seed used and the methods employed were often those with which the settlers had had experience in the East. These were not adapted to western conditions, and many failures resulted. In the settling, moving out, and resettling which has taken place, these mistakes often have been repeated. Here and there pioneers have remained, and as a result of their experience have adopted varieties of corn and methods of corn culture which are better adapted to the conditions. (Fig. 1.) Unfortunately, few records are left of the unsuccessful attempts, and the reasons for the better successes of the pioneers are little known except by the pioneers themselves.

It is the purpose of this bulletin to show in a general way some of the causes of these failures and how failures may be made less frequent or less intense. Particular varieties of corn and particular methods of cultivation are not applicable to the whole of any large area. Nevertheless, there are certain fundamental requirements of moisture, heat, and fertility which everywhere govern corn yields. A change in the supply of one may make a change in another advisable. Thus, the moisture requirement varies with the amount of heat available. In short, the secret of successful corn culture is to maintain a proper balance of moisture, heat, and fertility.

The region to which the principles and methods herein discussed are especially applicable can not be designated by average yearly rainfall or by definite boundaries, because the time of year when rains

NOTE.—This bulletin is especially applicable in dry-land regions; but corn yields are so dependent upon the relative amounts of soil moisture and heat that the principles here given apply wherever corn is raised.

occur, the nature of the soil, the rate of evaporation, and the temperature are all factors of great importance in determining the amount of moisture which can be made available to a corn crop.

WHY CORN GROWING IS ATTEMPTED IN SEMIARID REGIONS.

Farmers from the East, accustomed to obtaining good corn yields wherever the soil is fertile, have not readily understood that corn may not be the best crop for rich prairie soils. They are apt to think that the other man's failures were due to poor methods. They therefore do not adopt other varieties and apparently poorer methods until they have given eastern varieties and methods a trial under the new conditions. Thus, in some cases experience with corn under corn-belt

FIG. 1.—A characteristic view in the northern portion of the Great Plains, where vast areas are occupied by corn one year and by wheat or oats the next. In regions especially adapted to small grains a cultivated crop is needed in crop rotation. Corn frequently supplies this need.

conditions has proved a disadvantage rather than an advantage to new settlers in semiarid regions.

It is coming to be believed that diversified farming, including the raising of live stock, is essential to the establishment and development of a permanent agriculture in the semiarid sections of the West. This requires that a diversity of crops be grown and that the crops be such as furnish food for animals.

Transportation is often so difficult or costly that new settlers must grow the crops which supply food for themselves and their animals. Corn is therefore often grown under conditions less favorable to it than to other crops. To produce rough feed, corn is sometimes grown to advantage even under conditions so severe that it yields no grain. Most semiarid lands are comparatively cheap and easily prepared for corn.

The continued growing of small grain on the same land usually results in decreased yields and is recognized as poor practice. The need of a cultivated crop in rotations causes corn to be grown extensively in semiarid regions. Knowledge of corn and how to grow it gained in other sections naturally turns attention to it, and it is adopted in rotations. In some cases the soil improvement due to the cultivation of corn justifies the growing of this crop even when the crop harvested does not pay the entire cost of its production. In semiarid regions corn, as well as small grains, produces better after corn than after small grains. In sections having a long growing season the grain sorghums are likely to outyield corn and are well suited to extensive culture in rotation with small grains.

No methods have been found that overcome the effects of the most severe droughts. The growing of crops in droughty sections is always attended with more or less risk. The experienced farmer recognizes this and adopts those practices which enable him best to tide over unfavorable years. In those sections where the time of occurrence of drought or rains is uncertain, the growing of crops which mature at different seasons is a wise practice. In some seasons early rains and late droughts make good small-grain crops, while the corn crop fails. When the conditions of moisture and drought are reversed, small grain may fail and corn make a crop.

Attempts to grow corn on the natural rainfall of semiarid regions and secure large profits by marketing the grain will doubtless, as in the past, be attended with more failures than successes. Considering, however, the value of both grain and stover as feed, the importance of corn in rotations, the need of growing different crops to reduce the chances of an all-round failure, and the better results following the use of adapted varieties and suitable methods, corn has come to be recognized as an important crop for semiarid regions.

CORN NOT NATURALLY ADAPTED TO SEMIARID REGIONS.

Corn possesses characters which appear to make it adapted to droughty conditions. On the other hand it has characters which limit its possibilities as a crop for semiarid regions.

Corn is deep rooted and can, if necessary, draw water from depths of 5 or 6 feet. In hot, dry weather the rolling of the blades reduces the loss of water. Figure 2 shows a field of corn suffering from lack of moisture. In producing a given weight of food or dry matter, corn uses less water than certain other crops, such as oats, clover, or alfalfa.

The characters which make corn less adapted to semiarid regions than some other crops are its heat requirements and its peculiar flowering habits. Corn makes its entire growth during the season of highest temperature. It is naturally a tropical or subtropical plant

and makes its best growth during hot weather, when the thermometer registers 80° to 100° F. It can not grow in early spring or late fall, and growth is retarded during the summer months by cold nights or cool weather. It requires its greatest supply of moisture during the summer weeks, when droughts are most likely to occur and when rains are less effective on account of losses from evaporation. In other words, the heat requirement of corn prevents growth at times when the moisture conditions are likely to be most favorable, while lack of moisture frequently retards growth when the heat conditions are most favorable.

Unlike some perfect-flowered plants, such as alfalfa, which seed abundantly under dry conditions, the setting of seed or the filling of

FIG. 2.—A Texas cornfield in August. This crop was a failure because the soil moisture became exhausted just when the plants should have begun to form ears.

the ears is seriously interfered with by summer drought. Corn has two kinds of flowers, situated some distance apart on the plant. The tassel or pollen-bearing flowers at the top of the stalk are exposed to hot winds and sunshine. The pollen is further exposed in falling to the middle of the stalk to fertilize the silks of the seed-forming flowers. Droughty conditions often hasten the shedding of pollen but delay the appearance of silks. Thus, it sometimes happens that the pollen is mostly wasted before the silk appears. If fertilization is prevented in this way, no amount of later rain can cause kernels to form or make a good grain yield. The corn crop is thus sometimes injured by hot winds that do less damage to such crops as alfalfa and the grain sorghums.

SOME ESSENTIALS OF CORN PRODUCTION.

In the United States each year a billion five hundred million dollars' worth of corn is produced. Of what is this corn made? Mostly of water and air. With liquid taken from the soil by the roots and carbon taken from the air by the blades, the plant makes corn by the aid of the sun.

The chief essentials of corn production are water, heat, soil fertility, and seed. No one of these can be said to be more important than another. Where all are abundant except one (as water, for example), this one becomes the "limiting factor," and methods of supplying it become the important means of increasing the yield.

In our semiarid regions the soils for the most part are fertile, and the limiting factor is either water or heat. Raising corn may be likened to raising steam in an engine. Too much water lowers the temperature, whereas too little water is dangerous. Growth can take place only while there is a proper balance between heat and water. The two must be in the soil at the same time. Water falling as snow or rain before heat is present should be stored in the soil. The boiler should be filled before the fire is started.

In northern sections and at high altitudes the lack of heat limits corn yields, while in southern sections it is the lack of moisture. Abundant soil moisture reduces soil heat—desirable in the South, but undesirable in the North. Far north a soil with a wet surface is usually a cold soil. Here the conservation of heat is more important than the conservation of moisture. Evaporation keeps the soil cool. Soil moisture rises to the surface to replace that which evaporates. Cultivation checks the rise of soil moisture to the surface, enabling the surface to dry more rapidly. The dry surface then becomes warm by taking in heat, which otherwise would have been wasted in evaporating water from below. Corn cultivated late in the afternoon may be frosted that night, while adjoining uncultivated rows escape the frost. The more rapid evaporation caused by recent cultivation first cools the surface, but as soon as the surface dries, the soil becomes warm quicker and the crop grows more rapidly than it would have done without the cultivation.

A glance at the corn yields of Kansas, Nebraska, South Dakota, and North Dakota for the hot, dry summer of 1913 and for the cool, wet summer of 1915 shows the effects of unbalanced amounts of heat and moisture. (Table I.)

In 1913 the yields increased from Kansas northward. In 1915 the yields decreased from Kansas northward. Moisture was the limiting factor in 1913 and heat the limiting factor in 1915. North Dakota profited by the excessive heat of 1913 and Kansas by the excessive rain of 1915.

TABLE I.—*Yield of corn per acre in Kansas, Nebraska, South Dakota, and North Dakota, 1913 and 1915.*

Season.	Kansas.	Nebraska.	South Dakota.	North Dakota.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*
1913 (hot, dry summer)	3	15	26	29
1915 (cool, wet summer)	31	30	29	14

In northern localities, where lack of heat is a factor limiting corn yields, summer fallowing and moisture conservation tend to keep the soil cold and seldom give increased yields of corn. In southern localities, where lack of moisture is the limiting factor, summer fallowing and practices which increase soil moisture give increased yields of corn.

In the southern part of the Great Plains, lack of moisture is the chief limiting factor. Ignoring special instances and speaking generally, every operation should be conducted in such manner and at such time as to enable the soil to take in and retain water. But just how and when is this to be done? Should the land be plowed deep or shallow, in the fall or in the spring? On what date should corn be planted, and how many times should it be cultivated?

These questions can not be answered correctly by rule or by averages. Each field of corn presents a combination of conditions which demand consideration in answering these questions. Time-of-planting tests conducted yearly for 100 years at a particular station might show that the highest average yield had been obtained from corn planted on May 10, and the next spring might be so unusually warm and forward as to warrant planting in April.

GETTING MOISTURE INTO THE SOIL.

Everything corn gets from the soil is in liquid form. The crop can not grow unless the soil contains moisture to spare. Plants, even weeds, can not take over every bit of the moisture from the soil, no matter how much they may need it. It has been estimated that if it were possible to control the soil moisture so that none might escape except through the plants, a rainfall of 10 inches would be sufficient to produce a 50-bushel yield of corn. The soil moisture supply can not, of course, be so completely controlled under field conditions. Where corn growing is attempted under dry-land conditions the annual rainfall is more than 10 inches and the point of most importance is to get as much of it as possible into the soil. Moisture losses from run-off, evaporation, and seepage are always considerable and under some conditions exceed the amount used by the crop. The available soil moisture can be increased by assisting snow and rain to enter the soil and by preventing the escape of moisture except through the growing crop.

The first and most important step in dry-land corn culture is getting moisture into the soil. All cultural operations should be planned so as to have the soil surface in the best condition to take in water and prevent run-off during the period when rains are most likely to occur.

The ease with which soils take in, retain, or lose moisture depends mostly on their texture, physical condition, and surface slope. It is to the extent that cultivation can modify these factors that more water can be made available to the growing crop.

There are loose, open soils through which water pours as through a sieve, and there are tight, gumbo soils, which swell when the surface is moistened and become practically waterproof. Our semiarid regions contain types of soil between these two extremes, which, when an open, rough surface is maintained, can be made to take in nearly all the snow and rain that falls upon them.

Sandy soils take in water more readily than heavier soils; hence, less precaution is necessary to prevent run-off. The surface dries more quickly, thereby more promptly checking loss by evaporation. In sandy and gravelly soils the greatest loss may be from seepage to depths beyond the plant roots. Manure and decaying vegetable matter check seepage and improve soils of this character. As corn roots penetrate 3 to even 6 feet deep, larger yields of corn are frequently raised on sandy soils in semiarid regions than on surrounding hard soils.

The heavy, hard, or close-textured soils require the most cultivation to keep them in proper condition so as to prevent moisture loss from run-off and evaporation. Unless the surface is kept broken or somewhat rough, but little water will be absorbed during hard rains and a greater loss will occur from evaporation. To maintain the surface soil in proper condition, cultivation is necessary soon after heavy rains. If cultivation is too frequent, however, so that the surface becomes too fine, moisture can not penetrate readily and blowing of the soil is likely to occur.

It is of great importance that moisture be made to penetrate several feet below the surface. In most soils this penetration is slow, and during hot, dry weather surface evaporation is great. Surface moisture can not penetrate a frozen soil. Summer and fall precipitation has time to penetrate several feet deep and be in a position to support a growing crop the next summer. While it is seldom advisable to waste a whole summer in storing moisture for a corn crop the next year, it is advisable to begin storing soil moisture as soon as the preceding crop will permit. (Figs. 3 and 4.) The ideal seed bed for a good corn crop in semiarid regions is one with a loose, coarse surface and a subsoil well filled with moisture to a depth of several feet.

PREPARING LAND FOR PLANTING.

As lack of moisture, more than anything else, limits corn yields in droughty regions, the first question regulating each operation should be, "What will be its effect upon the soil moisture supply?"

Summer fallow, or the practice of clean cultivation without cropping during an entire summer, in order to make two years' moisture supply available for one crop, frequently results in the production of larger yields of corn, but the practice has not proved practicable. The cost of summer tillage is usually greater than the gain derived from the increased yield. It is seldom possible by this method to store enough moisture in the soil to supply the crop adequately if rains do not occur while the corn is growing. The losses from seepage and evaporation are considerable, and the young corn plants can not be

FIG. 3.—Breaking virgin land in South Dakota. A most important task in growing corn with scant rainfall is to get the water a foot or two below the soil surface. An open, rough surface during the fall, winter, and early spring tends to hold snow and rain.

prevented from exhausting the moisture supply before the ear-forming period, when they need the greatest quantity.

As soon as the preceding crop will permit, it is advisable to begin some preparation of the land that will prevent the loss of moisture and put the surface in condition to take in moisture. Cultivation after the removal of the preceding crop is profitable if it stops or prevents a growth of weeds. But if the growing season is past, dead weeds may catch more snow than would be caught by a cultivated surface.

Fall disking, or listing, is usually beneficial in putting the land in better condition to prevent the soil from blowing, to hold the snow, and to prevent run-off. (See fig. 5.) The penetration of moisture is slow, and when rains occur evaporation is rapid from hard soil surfaces, such as usually follow the growing of small grain. The chances of storing moisture are increased by loosening such compact surfaces

as early as possible. Whether plowing is necessary, however, depends very much upon the type of soil. Most heavy clay soils are best put in proper condition by plowing. Sandy or light loam soils should not be plowed in the fall and left bare during the winter in regions where soil blowing is likely to occur. If, however, it becomes advisable to plow such soils in the fall, blowing of the plowed area may be checked by top-dressing with barnyard manure. Young corn plants injured by blowing sand on fall-plowed sandy land not top-dressed are shown in figure 6. Deep plowing should always be done in the fall or very early in the spring, to allow more moisture to penetrate and the soil to settle before planting time.

FIG. 4.—Two plats of corn at Amarillo, Tex., listed at the same time, in the same manner, and with the same lot of seed. The fall and spring early disking of the left-hand plat enabled it to take in and hold more moisture and produce better than the right-hand plat, which was not disked.

On sloping land the plowing, listing, planting, and cultivating should follow on a level along the slopes or around the hills. This greatly decreases the run-off from melting snows and heavy rains and increases the amount of water taken in by the soil. The moisture saved makes this a profitable practice, and very often the prevention of run-off is necessary to avoid erosion, with the loss of the richest portions of the soil. (Fig. 7.) Profitable farming can not long continue unless soil washing is prevented. If a little is tolerated it rapidly grows worse and soon makes necessary contour farming, terracing, and the use of commercial fertilizers, when corn raising becomes unprofitable.

Alfalfa land to be prepared for corn should be fallowed one year or plowed early the previous summer. On account of its deep-rooting habit and the nitrogen it adds to the soil, alfalfa is an excellent preparatory crop for corn. Its roots dry out the soil to great depths, however, and unless the land is prepared a sufficient time in advance to allow moisture to be accumulated in the soil the chances of a failure of the corn crop are great.

Growing plants draw large quantities of water from the soil and subsoil. All growth of weeds and volunteer grain on land to be planted to corn should be prevented. Stirring the soil immediately before planting is usually profitable and often saves much labor in keeping the crop free from weeds.

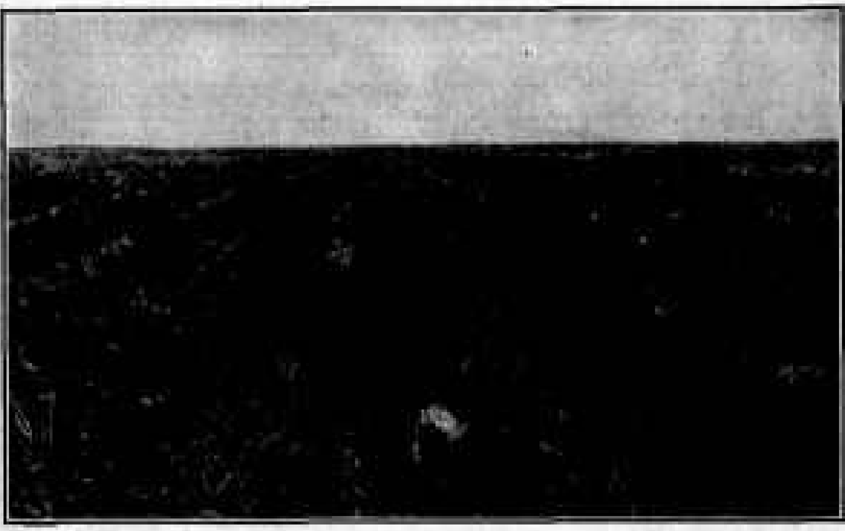

FIG. 5.—A field in western Kansas, showing fall-listed wheat stubble. The lister furrows prevent the drifting of snow and aid in getting the fall, winter, and spring precipitation into the soil.

Deep plowing and subsoiling should be done in the fall rather than at corn-planting time. Soil put in the right condition to take in moisture to a considerable depth is also open to the air and dries out rapidly. If necessary to plow in the spring for corn, the plowing should be done early and should not be deep, and the ground should be packed immediately. Plowing under several inches of snow is an effective and sometimes a practicable way of getting moisture into the ground.

TIME OF PLANTING.

Corn will not grow during as cold weather as wheat or oats. Corn-planting time is therefore a little later than the best time for sowing spring wheat or spring oats. However, when seed of perfect vitality is used it is remarkable how early in the spring corn can be planted and result in good stands and good yields. Seed of perfect vitality

will often remain in cold or dry soils for several weeks and afterwards germinate and yield well. Irregular stands (fig. 8) are sometimes attributed to poor seed, when dry, poorly prepared spots are the cause. Fields are sometimes seen in which the seed germinated promptly in moist spots but did not germinate in dry spots until rains came.

Where the seasons are long and moisture plentiful, it is customary to wait until the soil is warm before planting. In semiarid regions, however, corn should be planted early. With the soil in proper condition it is generally advisable in semiarid regions, south as well as north, to plant corn before danger from frost is entirely past. Corn planted very early usually makes a slow, tough growth and a month after planting may be smaller and look less promising than that

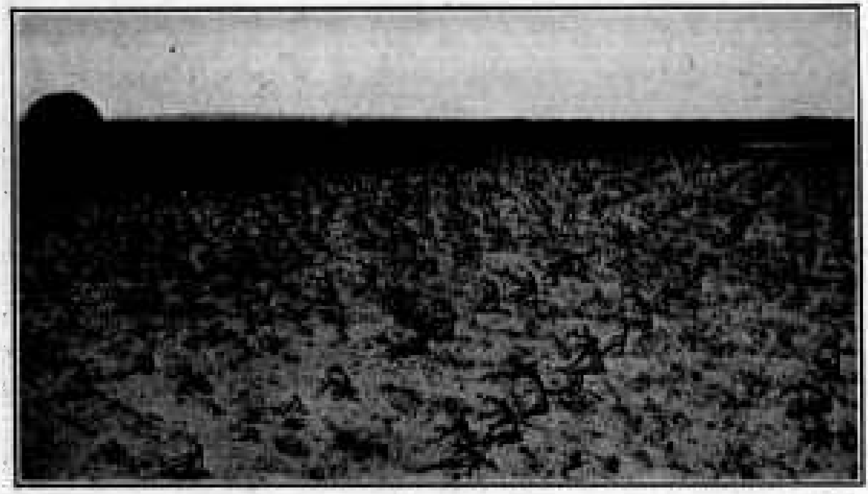

FIG. 6.—A cornfield injured by blowing sand. In some localities corn plants while young need protection. Long, narrow cornfields alternating with alfalfa or other sand-binding crops afford some protection.

planted later. The early-planted corn ripens first, however, and usually produces the larger or the better crop. Because of its slow, tough growth, corn planted very early is not so susceptible to frost and drought as corn planted later and growing more rapidly. In a series of years the gain in mature corn secured from early planting will more than make up for any injury from spring frosts. Excellent corn crops have been produced from plantings frozen off or frozen back when the plants were from a few inches to a foot or more tall. Corn is not often entirely killed by spring frosts, and if some should be injured the loss is much less serious than that from summer drought or from fall frost.

Early-planted corn derives more benefit from the spring moisture supply, becomes well rooted before summer droughts begin, and may even mature before these droughts become severe.

Where the growing season is very long and warm, plantings made at about 30-day intervals increase the chances of hitting the season right and raising some good corn.

METHODS OF PLANTING.

Listing, or planting in furrows, is the most common and best method of planting corn in a large part of the semiarid area. It is not only economical, as it permits large acreages to be handled at the least cost, but it also places the plants to the best advantage to withstand drought. As the furrows are closed by cultivation, the plant roots are placed well below the surface. A deep soil mulch can be maintained without injury to the roots. The plants are more securely braced to withstand winds than when surface planted.

FIG. 7.—A western Kansas cornfield, showing erosion of the soil. Soil washing reduces the moisture supply, the soil fertility, the yields, and the value of the farm.

In some semiarid sections early summer conditions are favorable for rapid growth. The plants make a tender, rapid growth and become larger than the later moisture supply will support. Listing retards this rapid early growth and is often a decided advantage on this account.

Where the seasons are very short, surface planting is better than listing, as the retarding of early growth leaves the plants insufficient time to reach maturity. Where surface planting is practiced on fairly level land it is usually advisable to plant in checks to permit cross cultivation. Cross cultivation makes weed and grass control easier. It also assists cultivation, drying and warming a larger part of the soil surface.

A thin stand of plants is an essential feature of successful corn growing in regions of limited moisture supply. When planting is done with a lister in rows 3 to 3½ feet apart, the plants should be one in a place and from 18 to 36 inches apart, depending upon the rainfall and the fertility and water-holding capacity of the soil. In surface-planted corn with the hills 3½ feet apart each way, the stand should not be thicker than two plants per hill. Even with the best of seed more kernels should be planted than the number of

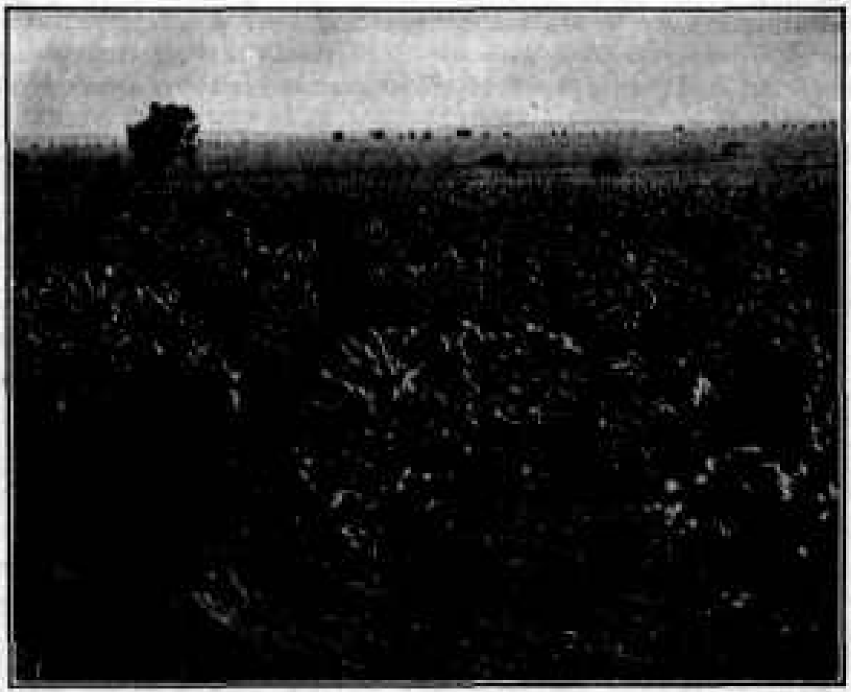

FIG. 8.—A western Nebraska cornfield showing an uneven stand. Irregular stands of plants sometimes result from dry or poorly prepared spots in the field. Note that some plants are much taller than others, indicating a better supply of moisture and earlier germination of the seed.

plants desired. Some young plants, mostly the weaker ones, will perish.

The usual distance between corn rows is about 3½ feet, which is a convenient distance for cultivating. With the rows at this distance the roots meet between the rows and occupy all of the upper soil before the corn comes into tassel.

In certain droughty sections, where the seasons are comparatively long, increasing the width of row to 7 feet (fig. 9) and doubling the stand in the row has been found to be an advantage. On account of being close together within the rows the young plants compete for the near-by moisture and are prevented from making too rapid and too tender a growth. The roots do not meet between the rows until

the plants have about reached their full growth, and the moisture in the soil between the wide rows benefits the plants at the time they are forming ears. Where the summers are long other crops or another crop of corn can be planted later in the season between the 7-foot rows if the seasonal rainfall proves sufficient.

The success of the crop depends upon having the corn reach the ear-forming period when moisture and heat are available at the same time. The chances are increased by making a very early and a late planting of an early-maturing variety. Using seed of an early-maturing variety in one planter box and seed of a late-maturing variety in the other box increases the chances of having some plants reach the ear-forming period when moisture and heat are available at the same time.

FIG. 9.—A western Kansas cornfield, showing rows 7 feet apart. Wide spaces between rows retain a part of the soil moisture for the critical or ear-forming period. Cultivation and the drilling of wheat, peas, or beans in the corn are made easier, as well as the harvesting of the corn.

Corn should not be covered with more than 1½ or 2 inches of soil except when the surface is dry and it is necessary to plant deeper to reach moist soil. In cold, heavy soils 1 inch is sufficient.

CULTIVATION.

In droughty regions corn cultivation is more essential and requires more good judgment than in most other sections.

The primary object of cultivation is to prevent loss of moisture. Moisture losses are caused by run-off, evaporation, and, most of all, weed growth. The one most important object of corn cultivation is the keeping out of weeds. In this it is true that prevention is better than cure. Cultivation should not be delayed until the weeds are large enough to cause the field to look weedy. It takes but little stirring of the soil to kill weeds immediately after they germinate and

before they have used much soil moisture, but to destroy weeds that are well rooted the soil must be worked deeply and thoroughly. This requires much labor and can not be accomplished without breaking and destroying many corn roots. In many sections, or in seasons when the seed germinates slowly, it is advisable to harrow once or twice or to cultivate after planting before the corn comes up.

Limited moisture makes thin stands necessary, and it is poor management to allow grass and weeds to rob the corn of this moisture. (Fig. 10.)

If cornland has been properly prepared deep cultivation is not advisable and often injures the crop. Deep cultivation should never be done close to the plants after they are a foot tall, as much harm would be done by breaking the corn roots.

Aside from destroying weeds, timely cultivation is beneficial in preventing the loss of moisture by evaporation and also in hastening the warming of the soil. The loss of soil moisture by evaporation continues much longer from a compact, damp surface than from a loose, dry surface, and the evaporation tends to keep the soil cold.

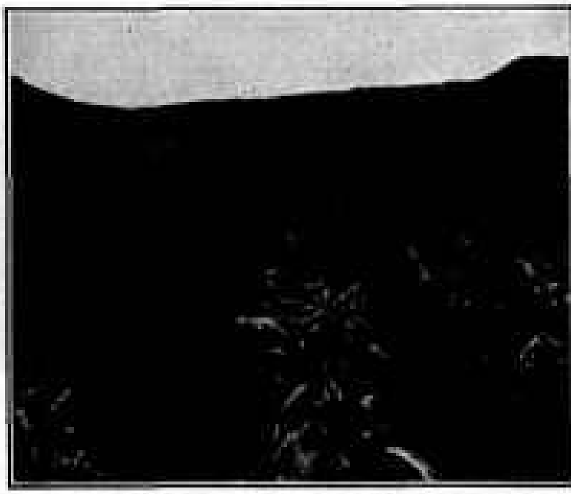

FIG. 10.—A cornfield in New Mexico, showing poor cultivation. Scant precipitation makes thin stands necessary, but a thick stand of grass and weeds is worse than a thick stand of corn.

In northern localities and at high altitudes the conservation of heat is frequently as important as the conservation of moisture. Luckily, both heat and moisture may be conserved by good, timely cultivation. Heat is wasted in evaporating or wasting soil moisture. Making the surface loose and dry saves both soil heat and soil moisture.

Cultivating after heavy rains is a good practice. To be most effective the cultivating should be done as soon as the surface is dry enough to work well. If the soil is allowed to dry until it breaks up cloddy, much moisture will be lost, a good mulch can not be obtained, and harm is more likely to be done to the corn roots. As long as rapid evaporation is taking place, the surface will remain cold and the growth of the corn will be slow. In order to cover large areas quickly, cultivators which work two or more rows are a great advantage.

Figures 11 and 12 show the first and second cultivations of listed corn with 2-row cultivators.

The number of cultivations necessary and the best time for them depend upon weather and soil conditions. Weeds should not be allowed to grow, and a mellow surface should be maintained. In some seasons this may be effectually accomplished with one or two cultivations; in other seasons from four to six cultivations may be necessary.

Nothing can be gained by continuing cultivation in cornfields free from weeds and in which the soil surface is mellow. When the surface is sufficiently loose and dry to reduce evaporation, is open enough to prevent run-off, and no weeds are starting, a cultivation could do no good and if carelessly performed would do injury to the corn.

FIG. 11.—The first cultivation of listed corn at North Loup, Nebr. The row at the driver's feet will be cultivated on the return trip.

Corn should be cultivated only when one or more objects will be accomplished by the cultivation and when the total effects will be more beneficial than injurious.

Some beneficial effects are (1) preventing weeds from robbing the corn of soil moisture and fertility; (2) putting the surface in condition to take in rainfall, thus preventing run-off and erosion—losses of water and soil fertility; (3) warming the soil by drying its surface quickly; and (4) saving moisture by checking its capillary rise to the soil surface.

Some injurious effects are (1) breaking corn roots, which otherwise would use some of the moisture of light showers before it evaporates; and (2) forming large clods and holes, thus permitting dry air to enter and dry the soil.

CORN GROWING UNDER IRRIGATION.

The greatest natural limitations to corn growing under irrigation in many semiarid sections are short growing seasons and extreme differences between day and night temperatures. These effects may

be partially overcome by growing early-maturing and adapted varieties, but it is not to be expectod that as large yields can be secured as are possible in sections where the seasons are long and temperatures more uniform.

Many failures, however, are due to preventable causes. The most common mistakes are overirrigation, too frequent irrigations, too early irrigation, and too little cultivation. The farmer who has been accustomed to regard a shortage of moisture as the chief cause of crop failure too often concludes that irrigation will cure all ills and insure large yields.

When tho surface soil is kept wet the temperatures are lowered by rapid evaporation, and the result is slower growth and delayed maturity. If cultivation be delayed until the surface soil begins to

FIG. 12.—The second cultivation of listed corn at North Platte, Nebr.

bake and crack, roots are exposed and cultivation may then be very injurious. (Fig. 13.)

Small corn plants do not require a large moisture supply. Early irrigations stimulate an excessive growth of stalk. The large, sappy stalks usually do not produce as much grain as those normally developed and are less likely to reach maturity before fall frosts occur.

On land that is well cultivated and kept free from weeds it is usually unnecessary to irrigate corn until about the time the tassels and silks begin to appear. A good supply of water is needed at this time, and irrigations are of much benefit to the plants in producing and developing ears. These irrigations should be thorough and followed as soon as possiblo by cultivation.

Irrigating in furrows or shallow ditches between the corn rows is better than flooding the whole surface and allowing the water to como in contact with the cornstalks.

The number of irrigations necessary depends upon the type of soil and the amount of moisture supplied by rain. On average loam soils two or three irrigations are usually sufficient. Late irrigations delay maturity.

ANIMAL AND INSECT ENEMIES.

Oftentimes in otherwise quite favorable locations the settlers' first attempts to grow corn are discouraging because the growing crop is

FIG. 13.—Corn cut away to show a baked and cracked soil. The corn should have been cultivated after the irrigation, as soon as the soil was sufficiently dry.

destroyed by prairie dogs, ground squirrels, gophers, blackbirds, cutworms, earworms, wireworms, chinch bugs, or grasshoppers. The crop often starts well and is very promising before it is destroyed by some of these pests. This sometimes leaves the impression that the crop would have been a good one except for the pests.

Where the chances are good that the crop will withstand the climatic and soil conditions, corn growing can be made to succeed notwithstanding the pests. Although they often destroy the small trial plats of a community, the injury from them usually diminishes from year to year as the corn acreage increases. Blackbirds, cut-

worms, gophers, etc., have for many years done damage to corn in the corn belt, but the crop is rarely destroyed entirely except in the case of small isolated fields.

Where cutworms, gophers, prairie dogs, or ground squirrels are obstacles to successful corn crops, poison should be used.

For cutworms, lumps of poisoned bait, made by mixing about 50 pounds of bran or corn meal with a pound of Paris green and enough cheap molasses to make a stiff dough, should be scattered along the corn rows at planting time or as soon as injury from cutworms is noticed.

Destruction by ground squirrels, prairie dogs, or gophers is best prevented by poisoning them a few weeks before the corn is planted. At this time they are readily killed by placing about their holes kernels of corn soaked in a solution of strychnine crystals. The corn may be poisoned by soaking it for a day or two in a solution made by dissolving about one-quarter of an ounce of strychnine crystals in a quart of denatured alcohol or boiling water.

Paris green and strychnine are poisons and should not be placed where children or domestic animals can get them.

PRINCIPLES GOVERNING THE CHOICE OF VARIETIES.

Although not especially suited to such regions because of its peculiar flowering habits and summer moisture requirements, corn will continue to be planted extensively in semiarid regions. Some of these plantings will fail, some will produce a little feed, and some will be more successful, depending upon the season, the soil, and the seed. The seasons are beyond control, the soil can be somewhat modified, and the seed can be greatly improved.

Corn has undergone great changes. Varieties exist which differ greatly in size, appearance, and requirements. Some varieties will mature with less heat and moisture than others, and some varieties more than others have the ability to withstand dry spells and revive when the drought is broken. For withstanding dry spells and cold, varieties which have been grown under these conditions for many years usually give the best results. The fittest have survived. Investigations and experiments now in progress indicate that varieties can be originated that will grow successfully at lower temperatures.

These adaptations and their limitations require attention in deciding what variety[1] of corn should be grown. These adaptations can be depended upon, but must not be expected to take the place of good preparation and cultivation of the soil. For example, in

[1] The semiarid regions of the United States are too extensive to warrant the mention here of particular varieties. The reader is referred to reports of variety tests made at his nearest State experiment station or substation and to United States Department of Agriculture Bulletin 307, entitled "Tests of Corn Varieties on the Great Plains."

Montana varieties should be used that withstand cold, but the soil surface should nevertheless be kept dry and warm by shallow cultivation. Varieties respond to moisture storing and conserving methods by growing larger, maturing later, and yielding better. Seed which will produce cornstalks 4 feet tall under droughty conditions may produce stalks 10 feet tall under favorable conditions.

While some varieties of corn have more ability than others to withstand dry spells and revive when the drought is broken, this ability is possessed to a greater degree by the grain sorghums, making their use as a grain crop more certain in droughty regions having four months or more of hot weather. Where the hot growing season is limited to less than four months, the ability to wait during drought is not an advantage, and corn succeeds better than the grain sorghums.

Experienced farmers in southern States hold different opinions in regard to the advisability of planting northern-grown seed corn and seed of very quick maturing varieties. In some seasons such varieties make good crops before droughts occur, and slow-maturing varieties suffer or fail altogether. In other seasons the quick-maturing varieties suffer, and later rains cause the slow-maturing varieties to produce the better crop. The chances of hitting the season right are increased by growing both a quick-maturing and a slow-maturing corn. (Fig. 14.)

If good, sound grain is desired, large-growing varieties are generally less satisfactory in semiarid regions than the smaller varieties.

The most successful corn crops are produced by giving attention to the growing requirements with regard to moisture, heat, and soil conditions, and the use of varieties best adapted to the conditions under which they are grown.

NEED OF GOOD SOURCES OF SEED CORN.

The need of sources from which suitable seed corn can be obtained in the semiarid and Rocky Mountain regions is great and is increasing. Being a sparsely settled country, subject to extreme seasonal variations, seed of adapted varieties is much scarcer each year than in sections where the corn crop is more certain.

Nothing else would so cheaply turn many corn failures into successes as the establishment of good sources of seed corn. While a knowledge of corn breeding would be helpful,[1] any farmer can do much toward supplying himself and his neighborhood with better seed corn by starting with a well-tested variety and selecting the best ears from the best stalks each year. By so doing, natural selection assists in weeding out the unfit. Where corn is grown for grain, there

[1] Those especially interested in the improvement of corn by methods of breeding can receive detailed information upon application to the United States Department of Agriculture, Washington, D. C.

is no better locality from which to obtain seed than that in which it is to be planted. Where grown for the silo or for large stalk growth, seed may be obtained to advantage from a more southern locality or a lower altitude.

Farmers' Bulletin 415 of the United States Department of Agriculture, which may be obtained free upon application, treats of the selection and care of seed corn.

A point of greatest importance is that of holding over from good crops sufficient seed corn for two or three years' plantings. This is essential in the origination and perpetuation of high-yielding varieties adapted to local conditions. Seed corn that matures well and dries out promptly without injury will keep its good germinating and yielding power for four or five years. Seed corn of the best quality can be always available by protecting a sufficient quantity from moisture and from insects and other animals.

FIG. 14.—A western Texas cornfield, showing an early variety alternating with a late variety. The early crop sometimes matures before droughts occur, leaving the summer rainfall entirely to the other.

PASTURING CORN.

The practice of turning fattening animals into cornfields to harvest the crop is increasing and is likely to continue to increase. It usually pays better to allow hogs the privilege of harvesting the corn crop than to market it in any other way. This practice saves the labor of cutting, husking, hauling to the feed lot, and hauling the manure back on the land.

The pasturing of corn is especially applicable to semiarid regions. The dry soil is not injured by the animals, and very little corn goes to waste or spoils by coming in contact with the soil. The stalks are left in good shape to prevent the drifting of snow. (Fig. 15.)

Flint and flour varieties frequently produce heavier yields than dent varieties under droughty conditions. They are unpopular, however, on account of the many small ears and the difficulty of husking. When harvested by animals this difficulty is overcome.

CONCLUSIONS.

In the conservation of the resources of the United States the improvement of the acre yield of corn and a less wasteful utilization of this crop are important.

The average acre yield is less than half what it might easily be made. The acre yield is increasing in the older settled States, but for the nation it has remained at about 27 bushels. This has been largely due to the expansion of corn growing into semiarid and other unsuitable regions. The acre yield for the nation will quite certainly be increased. They will profit most who produce larger acre yields while the average is low.

FIG. 15.—A portion of a South Dakota cornfield into which hogs have been turned to harvest the crop. It usually pays to allow hogs the privilege of harvesting corn.

While corn culture under droughty conditions is largely a matter of taking chances with seasonal conditions, certain controllable conditions of soil and seed often determine the success or failure of the crop.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1916